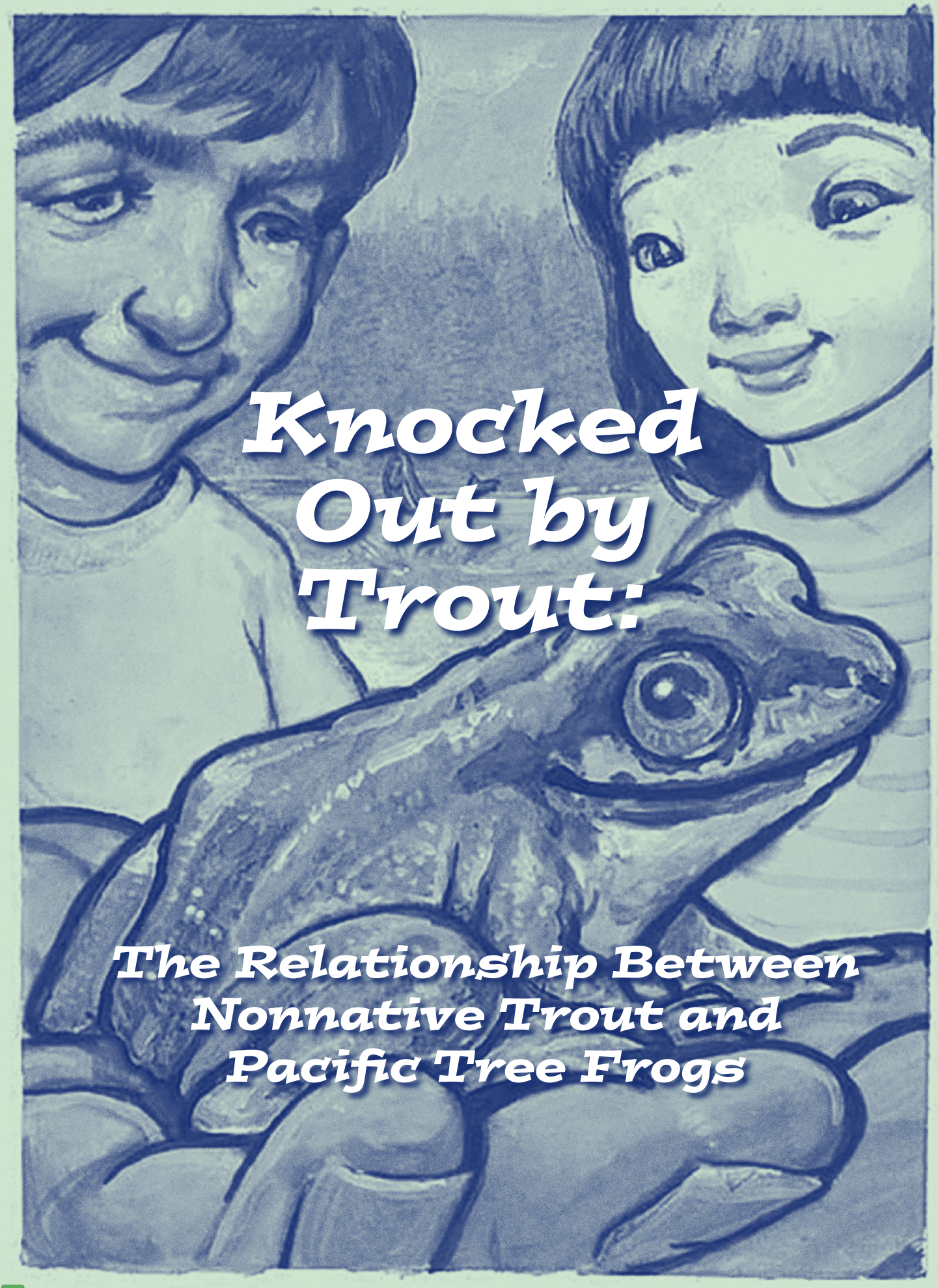
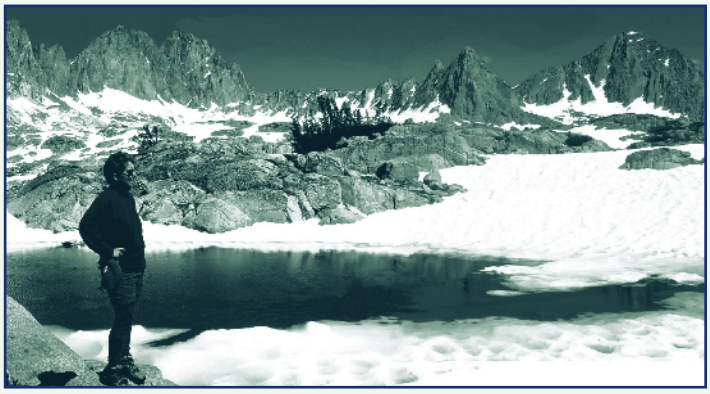


Knocked Out by Trout:

The Relationship Between Nonnative Trout and Pacific Tree Frogs

Meet the Scientists



Dr. Matthews: ▲ My favorite science experience was seeing the results of our research used in new *management* programs that led to increased amphibian *populations*.

Ms. Pope: ◄ My favorite science experience was learning about the different strategies animals use to survive in their natural environment. For example, mountain yellow-legged frogs survive the long, cold winter in the high Sierra Nevada mountains by finding pockets of water under the ice and breathing through their skin—for up to 9 months at a time.

Dr. Preisler: ► My favorite science experience is talking with scientists about a new *data* set!!!! For a statistician (**stat** uh **stish** un), happiness is a new data set! Statisticians are people who collect and arrange facts that are presented in numeric form. This photograph was taken in the Canadian Rockies.

Dr. Knapp: ► My favorite science experience is spending my summers in the mountains, counting frogs, catching bugs, and enjoying the most beautiful "office" in the world. This photograph was taken in the Sierra Nevada mountains, where this research was done.

Glossary:

management (**man** ij ment): Decisions and actions taken to achieve specific purposes.

population (päp yoo **la** shun): The whole number of individuals of the same type occupying an area.

data (**dat** uh): Facts or figures studied to make a conclusion.

biological (**bi** o **loj** uh kul): Having to do with plants and animals.

germination (jür mi **na** shun): The act of sprouting or beginning to grow.

nonnative (nän **na** tiv): Not naturally occurring in an area.

natural resource (**na** cha rôl **re** sôrs): A supply of something in nature that takes care of a human need, such as oil.

variable (**ver** e uh bul): Thing that can vary in number or amount.

native (**na** tiv): Naturally occurring in an area.

ecosystem (**e** ko sis tem): Community of plant and animal species interacting with one another and with the nonliving environment.

component (käm **po** nent): Any of the main parts of a whole.

fluctuation (**fluk** choo **a** shun): The act of continually changing or wavering.

species (**spe** sez): Groups of organisms that resemble one another in appearance, behavior, chemical processes, and genetic structure.

publicly (**pub** lik le): By the government, on behalf of all citizens.

Federal (**fed** ür ul): A union of States having a central government. A reference to this central government.

metamorphosis (met uh **môr** fuh sis): The process of change in the form of some animals from an immature stage to an adult stage.

equation (e **kwa** zhun): A written statement that indicates the equality of two expressions.

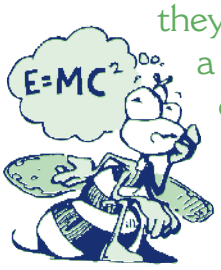
altitude (**al** tuh tud): Height; especially, the height above sea level.

Pronunciation Guide

a	as in ape	o	as in go	ü	as in fur
ä	as in car	ô	as in for	oo	as in tool
e	as in me	u	as in use	*ng*	as in sing
i	as in ice				

Accented syllables are in **bold.**

Thinking About Science



Although all *biological* scientists collect data, they know the differences between a study done in a laboratory and one done in the natural world. One difference has to do with the concept of control. When scientists want to discover the effect something has had on something else, they try to control the things that can vary, except for the things that they want to observe. This is much easier to do in a laboratory than in the natural world. In a laboratory, for example, if a scientist wants to discover the best temperature for seed *germination*, she can control the amount of heat reaching different seeds and compare their growth.

In the natural world, this kind of control is difficult to create. In this study, the scientists found an unusual situation in the natural world that enabled them to study the effect of *nonnative* trout on a tree frog population. In this study, you will learn how past and current natural resource management action controlled one of the most important *variables*, providing an opportunity for the scientists to study the relationship between nonnative trout and tree frogs.

Thinking About the Environment

In a *native ecosystem*, the living *components* have adapted together over time. This usually results in a stable ecosystem, meaning that within certain limits of *fluctuation* and possible continuous but slow change over time, the components remain about the same. This stability is threatened when a natural or human-created disruption occurs within the ecosystem. A natural disruption is something such as a hurricane, flood, or volcano. Human-created disturbances include things such as cutting down all the trees, mining, and building roads and buildings.

Another way that humans have created disturbances within stable ecosystems is by introducing nonnative *species* into these native ecosystems. When a nonnative species is introduced into a stable native ecosystem, the relationships that have defined that ecosystem change. Often, the nonnative species has a negative effect on the native ecosystem. In this study, the scientists wanted to know how the population of Pacific tree frogs was affected by the introduction of nonnative trout into lakes that had historically had no fish living in them.

Introduction

This study was conducted in the Sierra Nevada mountains of California (**figure 1**). Many small and large lakes are found in these mountains (**figure 2**). Historically, no fish lived in the lakes and frogs were abundant in the areas around the lakes.

Much of the Sierra Nevada mountains is *publicly* owned. The mountain range is managed by two *Federal* Government agencies, the U.S. Department of Agriculture (USDA) Forest Service and the U.S. Department of the Interior National Park Service. You can read about the USDA Forest Service on page 81, by visiting the *Natural Inquirer* Web site (http://naturalinquirer.usda.gov), or by visiting http://fs.fed.us. The National Park Service manages the

Figure 1. Location of the study sites in California.

Figure 2. A lake found within the Sierra Nevada mountains.

Nation's national parks, including Yellowstone, Yosemite, and Great Smoky Mountains National Parks. You can learn more about the National Park Service by visiting http://nps.gov.

This study took place in an area the USDA Forest Service manages in the southern Sierra Nevada mountains. This area is called the John Muir Wilderness, or JMW. You can read about wilderness by visiting the *Natural Inquirer* Web site and checking out the Wilderness Benefits Edition, or by visiting http://wilderness.net. In the 1950s, the California Department of Fish and Game began stocking the fishless lakes with nonnative trout to provide fish for fishermen. This practice has continued to this day (**figure 3**).

The National Park Service manages an area immediately south of the JMW called the Kings Canyon National Park, or KCNP (**figure 4**). In 1977, the National Park Service began to phase out stocking the lakes within KCNP with nonnative trout. By 2000, fewer lakes in KCNP than in JMW had trout living in them. In the lakes with trout, scientists found almost half the number of trout living in KCNP than in JMW.

Figure 3. Stocking the lakes with fish dropped from a plane.

Figure 4. The location of JMW and KCNP in the Sierra Nevada mountains.

In earlier studies, scientists found a relationship between nonnative trout populations and a particular frog population. The scientists found that when nonnative trout are present, the population of mountain yellow-legged frogs begins to decline (**figure 5**). This change occurs because trout eat frog eggs, which the frogs lay in the water.

The scientists were interested in discovering whether the Pacific tree frog population might also be affected by the presence of nonnative trout, similar to the way these trout had affected the mountain yellow-legged frog population. The scientists wanted to compare the populations of Pacific tree frogs with the populations of nonnative trout in JMW and KCNP (**figure 6**).

Figure 5. Mountain yellow-legged frog.

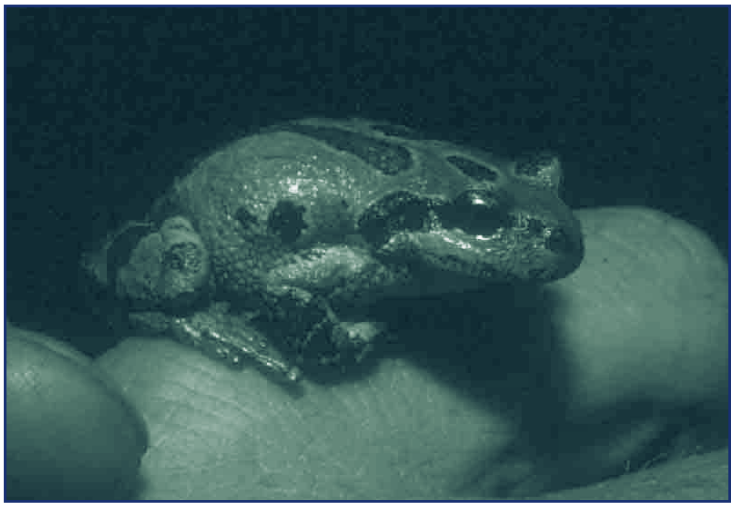


Figure 6. Pacific tree frog.

Reflection Section

- Basing your response on the information presented in the "Introduction," state in your own words what the scientists expected to find out about the population of Pacific tree frogs in JMW compared with KCNP. Then, give the reason for your statement.
- You read about the concept of experimental control in "Thinking About Science." (If you need a reminder, reread that section.) Which variable did natural resource management control, enabling the scientists to study the effect of nonnative trout on Pacific tree frog populations?

Method

In a laboratory, scientists can control most of the variables. When a change occurs or a difference is found, the scientists can be fairly sure what caused the change. In this study, the lakes in JMW and KCNP were almost identical. They had been historically fishless and are located very close to each other. The ecosystems of these lakes and the areas surrounding these lakes are very similar.

One difference is that the areas are managed by different Federal agencies. Before 1977, both agencies allowed the California Department of Fish and Game to stock the lakes with nonnative trout. Since 1977, the lakes in KCNP have not been stocked with nonnative trout and the lakes in JMW have continued to be stocked. You can see that this difference in management would be a good situation for scientists wanting to discover whether the number of nonnative trout can make a difference in the ecosystem of an area.

The scientists studied 669 lakes in JMW and 1,059 lakes in KCNP. The scientists walked the shoreline of each lake, recording the number of Pacific tree frogs that they saw (**figure 7**). The scientists recorded the existence of adult frogs, frog larvae, and frogs that had recently undergone *metamorphosis*

Figure 7. Sometimes it was difficult for the scientists to walk the shoreline and record the number of tree frogs that they saw.

(**figure 8**). The scientists also recorded the presence or absence of nonnative trout in each lake.

The scientists used an *equation* to learn the relationship between the presence of nonnative trout and the population of Pacific tree frogs. They entered the equation and their data into a computer. For each lake in JMW and KCNP, they entered the number of Pacific tree frogs found, as well as whether nonnative trout were present. The computer program was designed to tell them whether the tree frog population was about equal in each of the lakes, after considering the lake's size, *altitude*, and other considerations. The scientists did not include the presence of nonnative trout in the first calculations.

If the population of tree frogs was about equal after considering things such as size and altitude, the scientists could conclude that the presence of nonnative trout does not make a difference in the population of Pacific tree frogs. If the population of tree frogs was not equal, the scientists looked at whether nonnative trout had been found in the lakes where the tree frog populations were not equal.

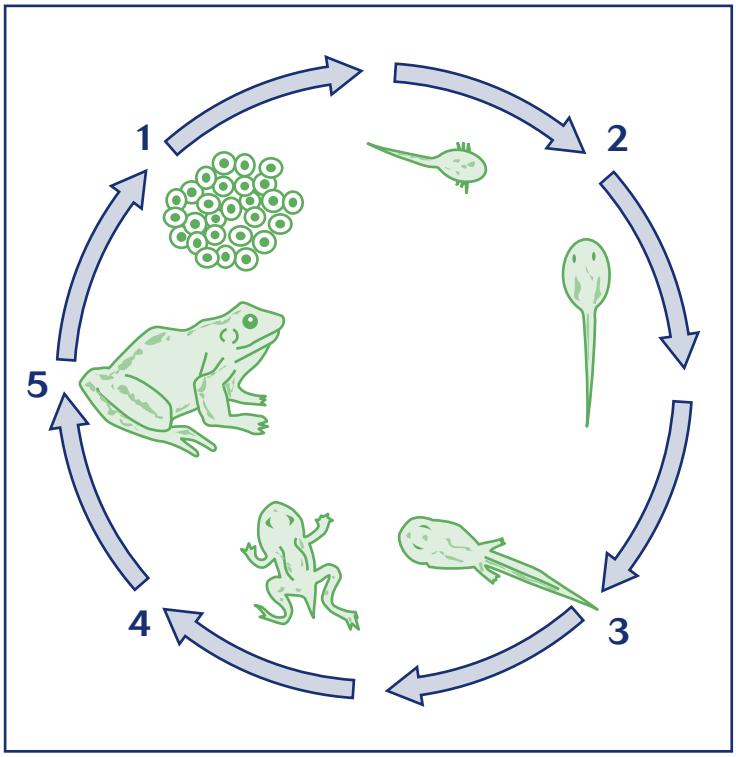


Figure 8. Frog metamorphosis.

Reflection Section

- Why did the scientists not include the presence of nonnative trout in their first calculations?
- Basing your thoughts on previous scientific findings about the presence of nonnative trout and the population of mountain yellow-legged frogs, do you think the scientists found a difference in the populations of Pacific tree frogs in JMW and KCNP? Why or why not?

Findings

The scientists found that 7 percent of lakes in JMW contained Pacific tree frogs, compared with 27 percent of lakes in KCNP. The percentage of the total water surface area containing tree frogs was almost 20 times higher in KCNP than in JMW. The lakes having the fewest nonnative trout were in the southern end of JMW and the northern and central sections of KCNP. The highest percentage of nonnative trout was found in lakes in the northern end of JMW. The scientists found this area to have the lowest percentage of lakes with tree frog populations.

The scientists considered all of the conditions that might affect the number of tree frogs present in a lake, such as its size and depth, and how much silt was in the lake. After taking these conditions into account, the scientists found that lakes with no trout were almost four times more likely to have tree frogs than lakes with trout.

Reflection Section

- Why do you think the scientists considered things such as the size and depth of the lakes and how much silt was in them?
- After reading the "Findings" section above, would you conclude that the presence of nonnative trout had an effect on the number of tree frogs in a lake? Why or why not?

Discussion

Previous research had shown a relationship between the presence of nonnative trout and a large reduction in other frog populations in the Sierra Nevada mountains. Because Pacific tree frogs are more widespread than mountain yellow-legged frogs, the scientists do not believe that nonnative trout will threaten the population of Pacific tree frogs. They do, however, believe that in high mountain areas where nonnative trout are present, the tree frog population will be reduced.

The scientists have also studied how the reduction in the tree frog population might affect the population of garter snakes in the high Sierras. Pacific tree frogs and other amphibians are a main source of food for these garter snakes. The scientists found that the continued stocking of high mountain lakes in the Sierra Nevada mountains with nonnative trout impacted garter snake populations as well. ■

Reflection Section

- Garter snakes are a source of food for skunks found in the Sierra Nevada mountains. Basing your thoughts on what you know about food webs and the results of this research, do you think it is likely or unlikely that continued stocking of nonnative trout could affect the population of skunks in the Sierra Nevada mountains? Why?

From: Matthews, K.R.; Pope, K.L.; Preisler, H.K.; Knapp, R.A. 2001. Effects of nonnative trout on Pacific tree frogs (*Hyla regilla*) in the Sierra Nevada. *Copeia*. (4): 1130–1137.

FACTivity

In this FACTivity, you will explore whether it is in society's interest to stock the Sierra Nevada lakes with fish or to stop stocking the lakes. You will use the following method:

1. Divide the class into five groups. Group 1 will consist of three students. The remaining students will be divided into four equal-sized groups. Two of those groups will be arguing in favor of continued stocking of the lakes with trout. The remaining two groups will be arguing in favor of stopping the stocking of fish.

2. Using the Internet and other sources, research the topic of stocking high mountain lakes with trout. Use search words such as:

   Sierra Nevada fish stocking
   Nonnative trout
   Sierra Nevada fishing
   Mountain yellow-legged frog

3. Prepare a list of reasons for and against fish stocking in the Sierra Nevada lakes. Depending on which side of the argument you will take, you will want to highlight your position. It is important to understand the other position as well, so do research on both sides of the argument. You may want to prepare visual aids to support your position. Each group should meet to decide on its approach to the debate. You may appoint one or two spokespersons to represent the group. The group of three students should be excused from doing this research.

4. The group of three students will function as a citizen advisory committee to the governor. While the other students are doing their research, this group will decide how they will make their decision about stocking. Will they vote? Will they insist on unanimous agreement? After listening to the arguments for and against stocking, the advisory committee will meet privately and discuss the issue. Then, the three students will make a decision about stocking and explain to the class why they made their decision.

5. Following the advisory committee's decision, hold a class discussion to review the entire exercise. How did the four groups feel about the advisory committee's decision? Did they feel that their position was fairly considered? Do all groups feel that the best interests of society have been served? Why or why not?

If you are a Project Learning Tree-trained educator, you may use PLT Pre K–8th Activity Guide #33, "Forest Consequences" or Pre K-8 Activity Guide #45, "Web of Life," as additional activity resources. These activities teach how different types of land management affect ecosystems and introduce how nonnative species change the web of life.